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ANYPHAENA (ARANEAE, ANYPHAENIDAE) OVERWINTERING ON LOWEST LIMBS OF WHITE OAK

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ABSTRACT. Juvenile *Anyphaena* sp. were collected from overwintering traps placed on the lowest limbs of white oak, *Quercus alba*, in South Carolina. Multiple regression analysis was used to determine that the number of juvenile *Anyphaena* sp. found can be predicted by the circumference of the limb, the distance from the trunk and the distance from the ground. This study helps demonstrate that the limbs of trees, although often neglected in overwintering studies, can provide a refuge for arthropods.

Keywords: *Anyphaena*, overwintering, *Quercus alba*

Many spiders enter a dormant stage during winter conditions (Schaefer 1977) and those that overwinter on the trunks of trees are often surveyed by collecting the spiders with cardboard wrapped around tree trunks (Tamaki & Halfhill 1968; Tedders 1974; Fye 1985; Mizell & Schiffhauer 1987; Pekar 1999; Horton et al. 2001). However, the species collected in the trunk traps are not necessarily the same species that are collected during warmer months from the limbs of the same trees (Pekár 1999; Horton et al. 2001) and the limbs are usually neglected when sampling for overwintering species. Our research was conducted to determine if the limbs of white oak trees, *Quercus alba* L., were suitable for arthropods to overwinter, and, if so, where on the limbs they overwintered.

METHODS

We made traps of gray coroplast (corrugated plastic, similar to cardboard) by cutting a sheet of coroplast into sections 15 cm long by 3–3.5 cm wide, providing six longitudinal cavities in each trap. We placed traps on three mature white oak trees, *Quercus alba* L., on 30 October 1998. One tree was located in Pickens County, South Carolina on the Clemson University campus. Two trees were located in Greenville County, South Carolina, one on the Bob Jones University campus and the other at Reedy River Falls Historical Park. Trees were selected based on ease of accessibility. Three sets of traps were placed on limbs greater than or equal to 3 m in length: one trap set was proximate to the trunk, one was in the middle of the limb, and one was on the terminus of the limb. Two sets of traps were placed on limbs shorter than 3 m in length: one trap set was proximate to the trunk and one on the terminus of the limb. We placed traps around the limb 2.5 cm apart, parallel to the limb, and held them in place with gray duct tape. The diameter of the limb determined the number of traps around the limb. Two groups of traps were place around the limb 3–6 cm apart, one offsetting the other (Fig. 1).

We used 5 limbs on the oak tree in Pickens County, each with 3 sets of traps. On the tree at Reedy River Historical Park in Greenville County we used three limbs, each with 2 sets of traps, and on the tree at Bob Jones University we used two limbs, each with 3 sets of traps. We used a total of 27 traps. The number of limbs used was based on the number of limbs reachable at each location with a 3 m ladder. For purposes of regression analysis the average circumference of the limb at each trap (circumference at both ends of the trap set divided by 2), the distance of the trap from trunk, the distance from the trap to the ground, and the branching of the limb from the trunk to the trap were measured. The bark surface was rated on a scale of 1–3, where 1 = smooth and 3 = rough.

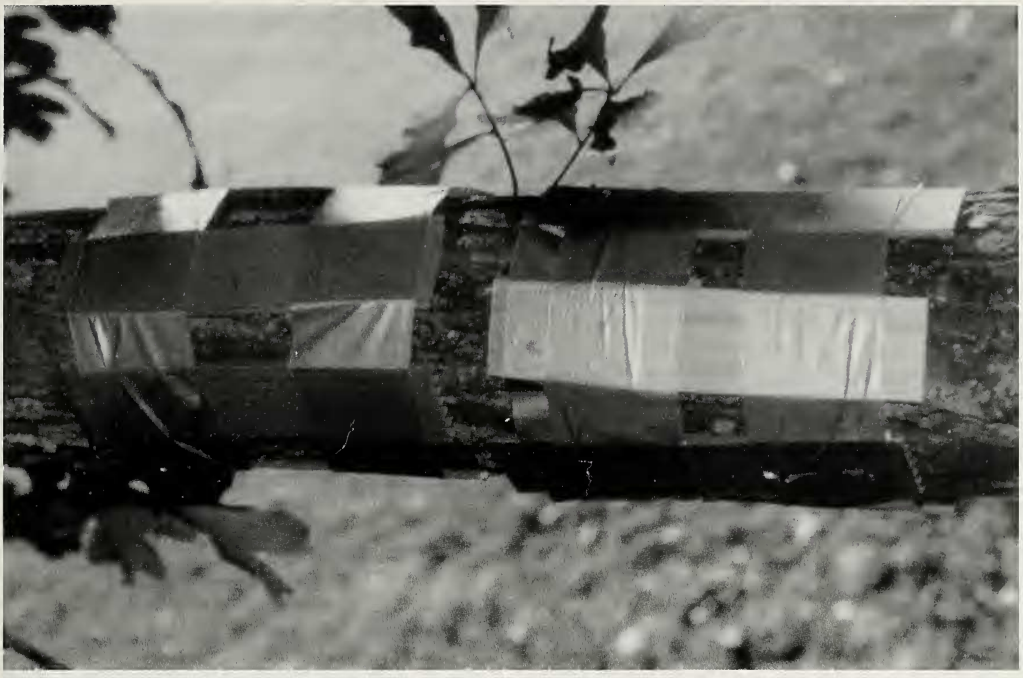

Figure 1.—One set of coroplast strip traps.

Traps were removed 24 February 1999 after three consecutive days of average daily temperatures near freezing (±1 °C) (average temperature for Greenville County was 0.9 °C for 22–24 Feb. and −0.4 °C for Pickens County). Traps were placed in plastic bags, taken to the lab and placed in the freezer. Specimens were removed from the traps, separated, preserved in 80% ethanol and identified. Voucher specimens were placed in the Clemson University Arthropod Collection.

Juvenile *Anyphaena* sp. were the only arthropods found in numbers large enough to conduct multiple regression analysis. The total number of *Anyphaena* sp. collected was 340. Multiple regression analysis was conducted using Minitab. The dependent variable was the number of *Anyphaena*, which was standardized for each trap set by dividing the total number of *Anyphaena* by the total number of traps in each set. The independent variables were average circumference of the limb, distance from the trunk, distance from the ground, number of branches per limb, and bark surface scale for each trap set.

For multiple regression analysis on *Anyphaena* no transformation of the dependent variable was needed. A tolerance test showed multicolinearity between polynomials of the independent variables and the independent variables. Therefore, only the raw independent variables were used in the analysis. Stepwise, forward, and backward model selection techniques all provided the same model. The model showed no systematic patterns, no outliers, and no evidence of lack of fit.

RESULTS

Spiders were the most numerous arthropods collected. All the arthropods collected are listed in Table 1. More *Anyphaena* sp. were collected near the trunk than the terminus of the limbs (Table 2).

The multiple regression analysis provide the following model: Number of *Anyphaena* sp. = −16.1 + 20.3 (circumference of limb) − 2.74 (distance from the trunk) + 9.86 (distance from the ground). This model, with an R^2 of 70.0%, shows that the number of *Anyphaena* overwintering in traps on the bottom limbs of *Q. alba* can be predicted by the circumference of the limb, the distance from the trunk and the distance from the ground.

DISCUSSION

Schaefer (1977) studied the overwintering habits of spiders and determined four overwintering habit types. *Anyphaena* sp. is part

Table 1.—Arthropods collected from overwintering traps around limbs of white oak.

Class	Order	Family	Species
Arachnida	Araneae	Agelenidae	*Coras* sp. juv.
		Anyphaenidae	*Anyphaena* sp. juv.
		Araneidae	*Araneus* sp. juv.
		Philodromidae	*Philodromus vulgaris* (Hentz)
			Philodromus sp. juv.
		Salticidae	*Eris militaris* (Hentz)
			Hentzia mitrata (Hentz)
			Metacyrba undata (De Geer)
		Thomisidae	*Bassaniana versicolor* (Keyserling)
Diplopoda	Polyxenida	Polyxenidae	*Polyxenus fasiculatus* (Say)
Insecta	Blattaria	Blattellidae	*Parcoblatta* sp. juv.
	Diptera	Syrphidae	*Syrphus* sp. juv.
	Hemiptera	Miridae	*Deraeocoris nebulosus* (Uhler)
	Psocoptera	Ectopsocidae	*Ectopsocus meridionalis* Ribaga

of the majority (45%) of spiders that overwinter in the juvenile stage (Schaefer 1977). Tree-dwelling spiders in the genus *Anyphaena* are nocturnal wanderers, typically living in foliage from spring through fall, but little of their ecology or behavior is known (Platnick 1974). They feed on aphids and other prey not typically active during the day (Marc & Canard 1997; Marc et al. 1999). *Anyphaena* spp. take refuge during the winter but can be active during warmer days (Turnbull 1960), increasing their ability for survival (Gunnarsson 1985). Other overwintering studies, that included *Anyphaena* spp., sampled only the trunk or the proximal end of the largest branch. Bajwa and AliNiazee (2001) found only four *Anyphaena* in a four year study. Horton et al. (2001) found only seven *Anyphaena* in a one year study. We demonstrated that *Anyphaena* will overwinter on most parts of the branches with refugia present.

Most refuges available to overwintering spiders are eliminated when leaves are shed. Previous studies have shown or suggested that after leaf-fall spiders move down from the crown until they find refuge (Duffey 1969; Horton et al. 2001), which might be the case with our spiders. The overwintering traps provided a refuge that otherwise would not have been available. The diameter of the limbs affected the number of spiders and without exception, the larger the diameter of the branch the rougher the bark, which might also provide refugia.

Table 2.—Mean number of *Anyphaena* sp. juv. (± SE) collected from coroplast traps on white oak, *Quercus alba* limbs (South Carolina, 1999). Limb position is relative to the trunk.

Limb position	Average # *Anyphaena* (*n*)
Proximate	17.4 ± 2.0 (10)
Middle	12.3 ± 2.8 (10)
Terminus	5.4 ± 1.3 (8)

Horton et al. (2001) collected arthropods from cardboard bands weekly 23 Aug–07 Dec 1999 in Washington apple and pear orchards. They found *Anyphaena pacifica* Banks in higher numbers (224 total) on a weekly basis than in overwintering samples (7 total, collected in Jan 2000). They suggested that the spiders overwinter elsewhere. In Oregon, *A. pacifica* was found in low numbers (0.35% of total catch) during the growing season by beating the branches over a net (Bajwa & AliNiazee 2001). In Europe, Marc et al. (1999) and Marc and Canard (1997) suggested that *A. accentuata* (Walckenaer) overwinters on the tree trunk, but they collected very few individuals (1% of total catch).

Our study provides information that can be used in further studies of overwintering arthropods on trees. The branches represent a large portion of the tree and are often neglected as a sampling site during the winter months. Large numbers of spiders on the limbs could alter decision made in integrated pest management for landscapes and orchards such as apple, peach, pear, and pecan.

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